FEDERAL FACILITIES in PUERTO RICO:

OPPORTUNITIES for ENERGY and WATER EFFICIENCY INVESTMENTS

United States Department of Energy RFQ-00-004

U.S. Department of Energy
Federal Energy Management Program
Atlanta Regional Office
75 Spring Street SW, Suite 200
Atlanta, GA 30303-3308

Project No. 310114.0100

Harding-ESE, a MACTEC Company
Advantek Consulting, Inc.

August 2001

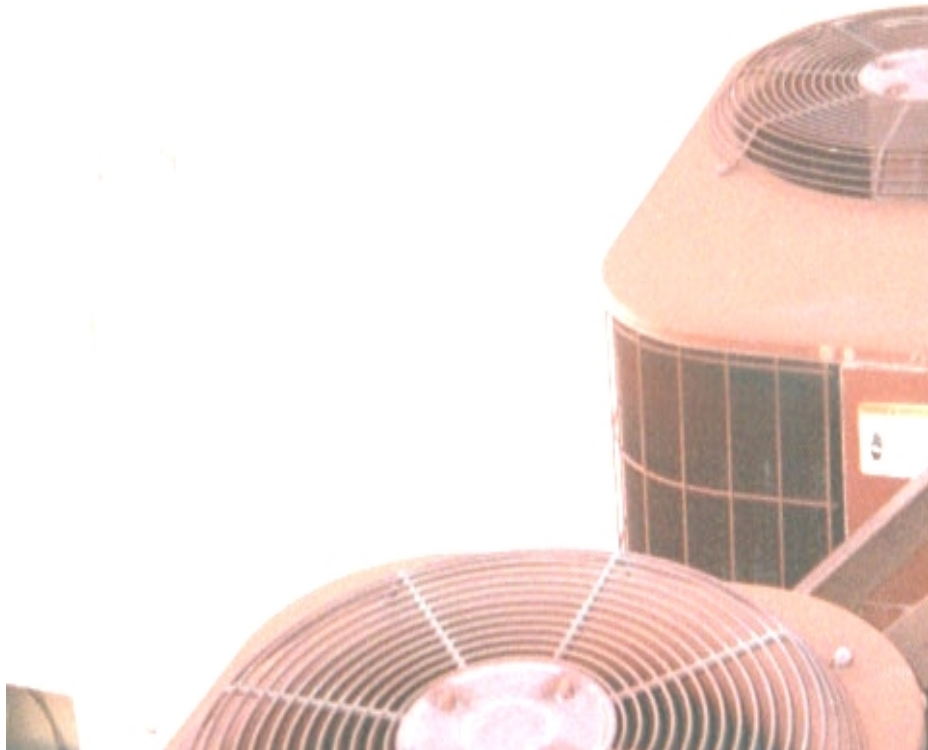


Table of Contents

Table of Acronyms

ARO	Atlanta Regional Office of the Department of Energy
DOE	U.S Department of Energy
DSM	Demand-Side Management
ECI	Energy Cost Index, Dollars per square foot per year
ESCO	Energy Service Company
ESE	Environmental Science & Engineering
EUI	Energy Use Index, Btu per square foot per year
FEMP	Federal Energy Management Program
FSEC	Florida Solar Energy Center
MVA	Mega Volt Amperes
NPS	National Park Service
O&M	Operations and Maintenance
OTEC	Ocean Thermal Energy Conversion
PURPA	Public Utilities Regulatory Polices Act
PV	Photovoltaic
REM	Resource Efficiency Manager
ROI	Return on Investment
USPS	United States Postal Service
PR	Puerto Rico
PREAA	Puerto Rico Energy Affairs Administration
VOC	Volatile Organic Compound
PREPA	Puerto Rico Electric Power Authority

1. Executive Summary

The intent of this study is to present a comprehensive plan and strategy for the identification and financing of energy and water efficiency improvements in federal facilities located in Puerto Rico. This document provides information that will be useful to the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) personnel in strategically targeting its resources towards achieving the goals of the Atlanta Regional Office (ARO) in the Caribbean. The intent is for leveraged partnerships and funding to ultimately lead to rapid implementation of energy efficiency projects in Puerto Rico financed with utility or private sector capital.

Federal facility energy use in Puerto Rico is about $21.2 million per year, and the overall energy cost index (ECI) is high at $2.18 per square foot per year. Water consumption expenditures for Federal facilities in Puerto Rico are estimated to be about $2 million per year. Because of their size, potential total dollar savings is greatest at Ft. Buchanan (U.S. Army) and Roosevelt Roads (U.S. Navy). The GSA buildings, the National Guard, the FAA facilities, and the Job Corps centers also have large potential dollar savings. Our findings indicate that potential annual savings are on the order of $5 to $8 million per year. This would support a project implementation budget of around $30 million.

Electric rates in Puerto Rico can be as high as $0.12 per kWh, roughly twice average U.S. mainland prices. The local government has few resources to invest in energy efficiency projects and many of the Federal facilities are too small to attract an energy service company (ESCO). Federal energy and facility managers are interested in implementing energy saving and

renewable energy projects; however, their needs are not well defined. Federal agencies have minimal resources to invest in energy efficiency projects at the local level.

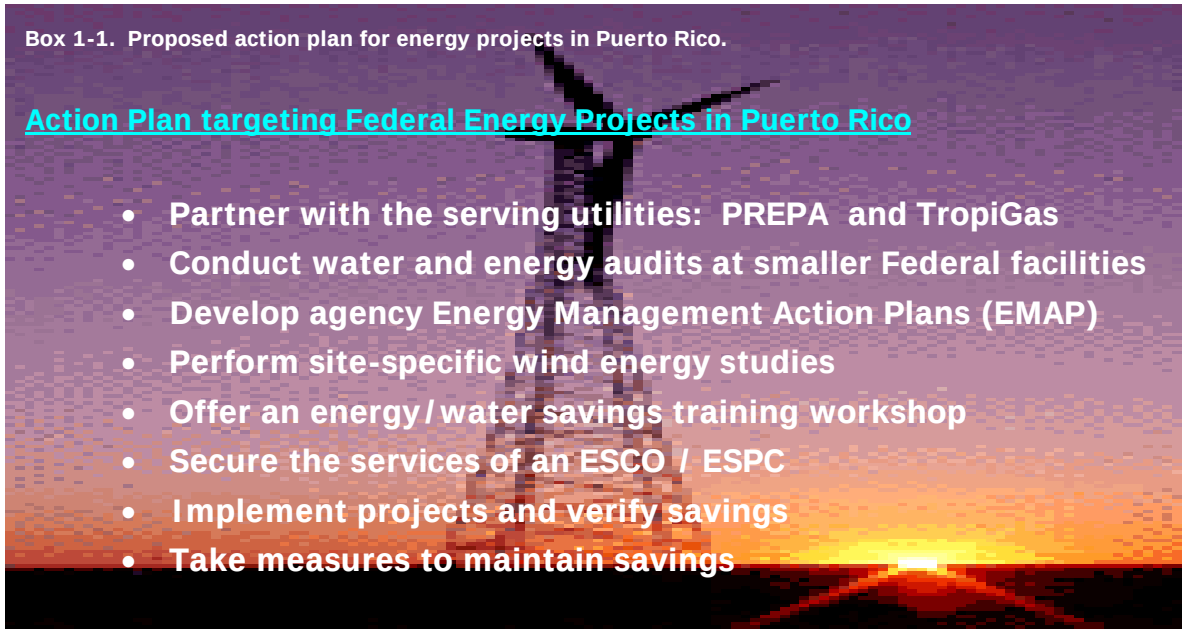
The common barriers to the implementation of energy efficiency and renewable energy projects in the U.S. Caribbean are: (1) the small size of federal facilities is insufficient to attract the interest of most ESCOs; and (2) there is a lack of awareness of the savings and other benefits available through energy improvement projects among many federal facility managers. In Puerto Rico, combining smaller federal sites into one aggregated performance contract might create a project with enough visibility and large enough to attract an ESCO.

It is proposed that the selected ESCO employ local contractors to the greatest extent possible in order to build local energy project implementation capabilities. This will help the local energy offices encourage technology transfer from the federal sector to the local private sector and continue implementation of energy projects beyond the present government effort. Following FEMP's lead, it is hoped that enough commercial and industrial operators decide to improve the energy efficiency of their facilities to have a significant beneficial effect on the local economy.

One potential action plan for federal facilities in Puerto Rico is provided. It aggregates smaller non-DOD and non-GSA facilities into a single performance contract. It also includes approaches for partnering with the serving utility and the local energy office, conducting energy and water audits, and providing training and / or strategic planning assistance.

2. Background

The mission of the U.S Department of Energy's (DOE) Federal Energy Management Program (FEMP) is to reduce the cost of Government by encouraging increases in energy and water efficiency and promoting renewable energy sources. This is accomplished by creating



partnerships, leveraging resources, transferring technology, and providing technical guidance and training. Each of these activities directly makes government more cost-efficient and promotes wise management of Federal financial and personnel resources.

The U.S. DOE's Atlanta Regional Office (ARO) is charged with increasing energy efficiency in the U.S. Caribbean. FEMP is specifically tasked with implementing Executive Order 13123. The order directs agencies to reduce building energy use 30 percent by 2005 and 35 percent by 2010. The ARO's goal is to partner with Federal agencies in the Caribbean to assist them in meeting

these requirements while stimulating public-private partnerships to improve the region's energy efficiency, economic stability, and curtail its almost total reliance on imported fuel oil for electric generation.

The intent of this study is to present information leading to a comprehensive strategy for the identification and financing of energy and water efficiency improvements at Federal facilities located in Puerto Rico. This document provides details that will be useful to DOE / FEMP personnel in strategically targeting its resources towards achieving the goals of the ARO in the Caribbean. The intent is for leveraged partnerships and funding to ultimately lead to rapid implementation of energy efficiency projects in Puerto Rico financed with utility or private sector capital.

The U.S. DOE / FEMP competitively selected energy consultants (Harding-ESE and Advantek Consulting, Inc.) to identify energy conservation and renewable opportunities and obstacles to their implementation at federal facilities in Puerto Rico. The combination of high utility rates and antiquated building infrastructure almost ensures that energy conservation projects could be implemented successfully and with a high return-on-investment (ROI). The abundance of solar and wind energy and dependence on a sole utility provider are just two of many indicators of the potential for enormously successful renewable energy project implementations in the region. Nonetheless, the region currently lags many years behind the mainland U.S. in terms of both technology level and project execution.

3. Objectives and Methodology

3.1 Primary Objectives of this Study

1. Identify and document opportunities and resources for increasing energy and water efficiency and renewable sources of energy in Puerto Rico.
2. Identify obstacles to energy project implementations in Puerto Rico.
3. Develop a comprehensive strategy and action plan for financing and implementing renewable and energy and water efficiency projects at federal facilities located in Puerto Rico.
4. Assist the DOE Atlanta Regional Office (ARO) in fostering a productive relationship between the ARO and the federal agencies located in the Caribbean, and in marketing FEMP services.

3.2 Project Activities

Harding-ESE and Advantek collected information on the opportunities for and obstacles to implementation of energy/water efficiency and renewable energy projects using all accessible resources. Data and information was collected, compiled, and analyzed using a cost-effective mixture of activities:

- Interviews and meetings with key staff of Puerto Rico Energy Affairs Administration (PREAA);
- Review of previous related programs, studies, and publications;
- Tours of facilities with agency Energy Managers, PREAA representatives and local maintenance personnel;
- On-site data collection from facility energy and water using equipment;
- Utility billing statements from energy managers and/or the serving utility company;
- Telephone conferences, meetings, and discussions with DOE-FEMP personnel;
- Discussions with ESCOs;
- Internet accessible resources; and

- Meetings with and subcontracting to the Caribbean Alliance for Sustainable Tourism (CAST) to provide a comprehensive summary of energy-efficient and renewable products and services available in the region.

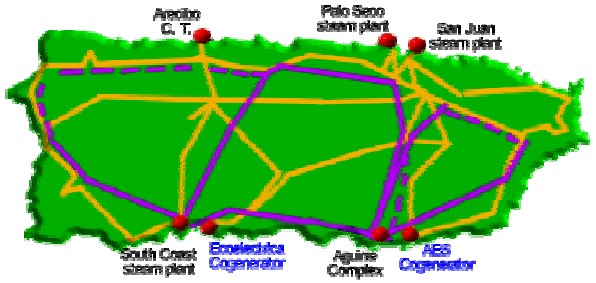
A kick-off meeting in San Juan at the Puerto Rico Energy Affairs Administration in the Department of Natural Resources building was held on January 22, 2001. The meeting was scheduled to coincide with the SAVEnergy Audit program being conducted January 15-27 by Global Energy Partners in Puerto Rico. Representatives from eight federal agencies were invited to attend the meeting; six of the agencies sent representatives in addition to four representatives from the Puerto Energy Affairs Administration (PREAA). Facility surveys were performed and follow up meetings held with DOE, the USVI Energy Office, and Ft. Buchanan Staff. A second round of surveys was conducted March 27-30. Harding ESE personnel met with the Fort Buchanan energy manager on June 4 to discuss strategies for project implementation. A final meeting was conducted June 28 in Atlanta to discuss report findings, recommendations, and presentation of results.

4. Electric Utility Status

Puerto Rico is somewhat unique in that one user-owned utility provides all electric service on the island and an abundance of solar and wind energy is available. For comparison, the total power plant capacity of Puerto Rico is about fourteen times that of the U.S. Virgin Islands, and annual electric consumption is about eighteen times that of the Virgin Islands. The overall cost of power to the 1,300,000 customers in Puerto Rico is about twice that of the mainland U.S. Energy use per customer is about 13,000 kWh per customer per year in Puerto Rico.

4.1 Resources and Management

All electric sales in Puerto Rico are under one sole entity known as the Puerto Rico Electric Power Authority (PREPA), a public corporation and government agency. PREPA is directed by a Government Board comprised of nine members. Seven of its members are appointed by the Governor of Puerto Rico with the approval of the Senate. Two of them represent the customers who elect them.



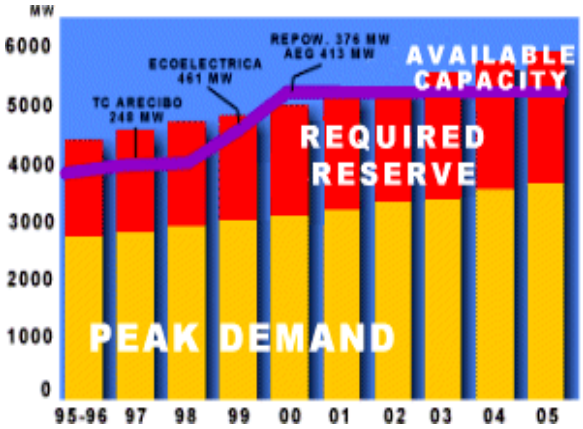
For administrative purposes, PREPA has divided the Island into 7 regions, with a total of 34 client service offices and 29 technical services offices located throughout the Island. PREPA's work force is comprised of 10,200 employees. They serve 1.3 million customers from which total revenue is about 1.73 billion dollars. The average revenue per kWh sold is $0.097. (For perspective, Florida is the nearest State with similar climate. Florida's utilities serve 8 million customers from which total revenue is 12 billion dollars at an average price of $.0685 per kWh. In February 1999, Intergraph Corporation won a $26.4 million contract from PREPA to provide an integrated resource management system, enabling PREPA to manage electric transmission and distribution lines more effectively. The transmission system is made up of 230 kV transmission lines (purple lines on map), 115 kV (yellow lines) and 38 kV sub-transmission lines. The system has 174 transmission centers.

Few, if any energy efficiency and DSM services are offered by PREPA. For example, their tip brochure on air conditioning advises: "Look for the unit with the highest energy efficiency

rating (EER). An EER of 8 is considered good, while 10 or more is excellent." In fact, most energy codes require that all air conditioning equipment have an EER rating of at least 10, and the minimum allowable Seasonal Energy Efficiency Ratio (SEER) was recently raised to 12.0. In sharp contrast, PR cogeneration plant owner Enron offers comprehensive worldwide energy and facility management services.

4.2 Capacity

Energy is converted at five main power plants: four were constructed between 1956 and 1975 (burning #6 oil) and one was completed in 1997 (burning #2 oil). The capacity totals 4,575 MW and 98% of the total electric production is fueled by petroleum. Coal supplies 1.4% and about 1% is hydroelectric. (For perspective, this is about 10% of the generating capacity of Florida utilities). Usage is about 17.1 billion kWh with a 7% transmission loss. Annually, PREPA consumes approximately 32.5 million barrels of oil (about half of Florida's use). PREPA buys this oil using a competitive bidding process among fuel suppliers Caribbean Petroleum Corporation, Galaxy Energy USA, Trafigura AG, and Veba Oil Supply & Trading. PREPA stores sufficient fuel to operate for 25 days



PREPA's plans to satisfy the increasing demand for power include diversification of fuel and the modernization of the generation infrastructure. The increase in power generation required for the next ten years, according to their expansion plans, will be provided through a combination of energy generated by PREPA and energy bought from independent producers (primarily in the cement industry). The option to build more plants was evaluated by PREPA and found costlier than co-generation. If PREPA had decided to build new generation plants, a rate increase would have been inevitable. After a financial evaluation, PREPA found that in addition to the $1.6 billion loan PREPA needed to improve the system, they would need an additional $1.2 billion to build new plants

4.3 Distributed Electric Generation

A unit qualifies as a cogenerator if it produces electricity and, at the same time, generates steam or a secondary product, and uses it or sells it to another company. Contracts have been signed

with two cogenerators: Ecoeléctrica (owned by Enron and Kenetech) and AES of Puerto Rico. PREPA buys electricity from the cogenerators as long as the price is less than or equal to what it would cost them to produce it in their own plants.

Ecoeléctrica's cogeneration project consists of a combined cycle plant that uses propane gas / LNG imported from Trinidad to generate 461 MW. The project includes a desalination plant that will utilize waste heat to produce approximately two million gallons of clean water per day for use in the power plant and to supplement the public water supply. The required investment for this technology is $670 million. AES's plant will use a fluidized bed boiler as fuel to generate 413 MW. Clean coal technology will require an investment of approximately $700 million. In addition, the Department of Defense (DoD) must privatize its utility systems by September 30, 2003; Enron is aggressively pursuing this opportunity.

There is considerable opposition to the construction of these cogeneration plants due to concerns about pollution, accidents, and increasing water salinity. *e."*

4.4 Renewable Energy

Since 1982, the U.S. Department of Energy has funded numerous small renewable energy research and development (R&D) projects in Puerto Rico, including research of sugar cane as a possible source of biomass power. DOE's involvement is in response to legislation enacted in 1980 which recognized that "Puerto Rico [and] the Virgin Islands … are virtually completely dependent on imported sources" of energy and directed the Secretary of Energy to prepare a comprehensive energy plan with emphasis on indigenous renewable sources of energy. DOE submitted a study of these areas to Congress in December 1982 (The 1982 Territorial Energy Assessment). Examples of renewable energy systems already in place in Puerto Rico include a cogeneration plant that uses sugarcane waste, a 100-kiloWatt photovoltaic installation at Juana Diaz, and the installation of more than 40,000 solar water heaters.

Companies continue to research ideas for waste-to-energy plants. One prospective investor has proposed a $200 million plant which would consume 2,000 tons of waste daily and produce 50 MW, while another suggests a plant costing twice as much, but which could accept 3,300 tons daily of a wider range of waste, and produce 72 MW. Much of the viability of these ideas depends on whether the plants can deliver power at a competitive price, especially compared with the island's main energy source, oil. Investors have discussed with PREPA less conventional sources of power, such as ocean thermal energy conversion plants, but this is still at the discussion stage.

DOE has an ongoing project with Puerto Rico to develop its energy-related research capability and, at the same time, address local needs for high-efficiency, environmentally safe energy alternatives. To achieve these objectives, Puerto Rico is supporting the establishment of three research clusters: High Energy Particle Physics; Novel Thin Film Materials for Optoelectronics Applications; and Catalytic Processes for Photo-oxidation, Combustion and Environmental Detoxification. The project is part of the Experimental Program to Stimulate Competitive Research (EPSCoR), which is funded through the National Science Foundation and managed by the EPSCoR Interagency Coordinating Committee (EICC).

5. Project Opportunities

Electric rates in Puerto Rico can be as high as $0.12 per kWh, roughly twice the average U.S. mainland price. The local government has minimal resources to invest in energy efficiency projects and many Federal facilities are too small to attract an ESCO. Federal energy and facility managers seem interested in implementing energy saving and renewable energy projects; however, their needs are not well defined. Federal agencies have minimal resources to invest in energy efficiency projects at the local level.

5.1 Federal Facilities by Agency

U.S. ARMY – FT. BUCHANAN

Fort Buchanan occupies about 476 acres just south of Old San Juan and is the only active Army post in the Caribbean. Its original 1,500 acres were occupied by the U.S. Army from 1940 until 1966 when the U.S. Navy took over. It was returned to the Army in 1973 and became the headquarters for U.S. Army South in 1999.

There are about 100 buildings typically 5,000 to 10,000 square feet each in size, and a few larger facilities ranging in size up to 30,000 square feet, totaling 690,000 square feet. In addition, residential housing totals 450,000 square feet, and community buildings, including schools, total 737,000 square feet. Total square footage is 1.88 million. Total electric energy cost in FY2000 was $4.2 million, at an average rate of $0.974 per kWh. Of this amount, 16% ($676,000) is military housing (residential) electric use. The energy cost index (ECI) for non-housing is $2.47 per square foot per year. The ECI for housing is $1.50 per square foot per year. Comparison of FY2001 to date with FY2000 indicates an increase in electric consumption by 15%, and a rate

One of many inefficient air-cooled chillers at Ft. Buchanan. The condenser coils are in very poor condition due to salt air corrosion.

One of many large buildings at Roosevelt Roads Naval Station. This one houses the Energy Manger's office.

increase to $0.11 per kWh. Water consumption in FY2000 was about 100 million gallons at a cost of $403,500.

U.S. NAVY - ROOSEVELT ROADS

The U.S. Naval Station is located approximately 35 miles east-southeast of San Juan, Puerto Rico, on the extreme eastern portion of the island. The station has an area of 8055 acres consisting mostly of grass and brush covered hills and a shallow valley that is oriented northeast to southwest. Annual electric cost is about $13 million per year. Despite our best efforts to obtain detailed utility bills and facility building information from this agency, we were unable to do so.

UNITED STATES POSTAL SERVICE

The USPS operates 134 facilities in Puerto Rico ranging in size from 224 sq ft (La Plata Main Office) to 222,194 sq ft (San Juan GPO). The total square footage is 1,225,000 with an average facility size of 9,142 sq ft. It should be noted that only 26 of these facilities are greater than 10,000 sq ft. For a complete list of facilities please see Appendix A. Total annual electric cost is approximately $2.4 million.

GENERAL SERVICES ADMINISTRATION

Five buildings are operated by the General Services Administration (GSA), and approximately 70 are leased. The three main GSA buildings total 621,000 square feet. Combined energy cost is at least $1.4 million per year, most likely much more; and water cost is $48,000 per year. The overall ECI is $2.34 per square foot per year.

The Federico Degetau Federal Building in Hato Rey, built in 1976, is eight stories with a basement. The building's 406,363 square feet are used mostly for offices, courtrooms, and support facilities. Annual electric cost is about $1.1 million per year with an ECI of $2.69 per square foot per year. Annual water charges are about $28,400 per year. The GSA Service Center in Guaynabo was built in 1940. The building's 110,918 square feet are used mostly for offices of various federal agencies and support facilities. Annual electric cost is reported by the

The Federico Degetau Federal Building

The GSA Toledo Building in San Jaun

Center to be about $30,600 per year – however this amount apparently does not include all energy charges / electric meters because it would mean a much too low ECI of $0.28 per square foot per year (or the square footage is much less than reported). Annual water charges are about $14,600 per year..

The Toledo Building in San Juan, built in 1924 and renovated in 2000, is seven stories. The building's 103,742 square feet are used mostly for offices, courtrooms, and support facilities. Annual electric cost is about $330,000 per year with an ECI of $3.18 per square foot per year. Annual water charges are about $5,400 per year.

PUERTO RICO NATIONAL GUARD

The San Juan Headquarters building is approximately 50,000 square feet. Annual FY-00 electric costs for Camp Santiago were $848,000, and for Fort Allen were $350,200. Despite our best efforts to obtain specific utility and building information from this agency, we were unable to obtain detailed information.

FEDERAL AVIATION ADMINISTRATION

There are four main occupied and several unmanned facilities operated by the Federal Aviation Administration (FAA) in Puerto Rico. The buildings total 86,400 square feet. Combined energy cost is $627,000 per year and water cost is $14,000 per year. The overall ECI is $7.26 per square foot per year.

The four main occupied FAA buildings are the Isla Grande Air Traffic Control Tower (Isla Grande ATCT), San Juan Air Traffic Control Tower (San Juan ATCT), CERAP, and the San Juan Utility Building, with total area of 70,321 square feet. These buildings are used for various purposes including air traffic control, office, storage, and a workshop. Total floor area is 76,994 square feet. Combined occupied building electric cost is about $471,000 per year, and annual water charges are about $14,000 per year. The combined ECI is $6.12 per square foot per year.

There are 12 main unmanned FAA remote electronics sites: Borinquen VOR, Dorado NDB, Mayaquez RCAG, Mayaquez VOR, Ponce VOR, El Yunque RCAG, San Juan ASR Radar, San

The National Guard San Juan Building is air conditioned by many inefficient units in very poor condition.

A waterless urinal pilot test is underway at the National Guard Headquarters building in San Juan.

Juan Glide Slope, San Juan Localizer, San Juan NEXRAD, San Juan OM, and San Juan VOR. Total area is 9,381 square feet. These buildings are used for air traffic control. Combined electric cost is $156,000 per year.

DEPARTMENT OF LABOR – JOB CORPS

Three Job Corps Centers are operated by the Department of Labor (DOL) Employment and Training Administration. The three centers total 257,000 square feet. Combined energy cost is $405,000 per year and water cost is $128,000 per year. The overall ECI is $1.57 per square foot per year.

The Arecibo Center was built in 1968 and turned over to the Department of Labor in 1986. The center comprises 32 buildings on 11.4 acres of land in the Cambalache State Forest. The buildings total 69,456 square feet and are used as offices, dormitories, and facilities support space. Annual electric cost is about $100,000 per year, and annual water charges are about $17,000 per year.

The Barranquitas Center was formerly a hotel, which was converted into a Job Corps Center in 1985. The center is comprised of 18 buildings on 12 acres, with a total floor area of 69,456 square feet. The buildings are primarily used as offices, student housing, and support facilities. Annual electric cost is about $98,000 per year, and annual water charges are about $41,000 per year.

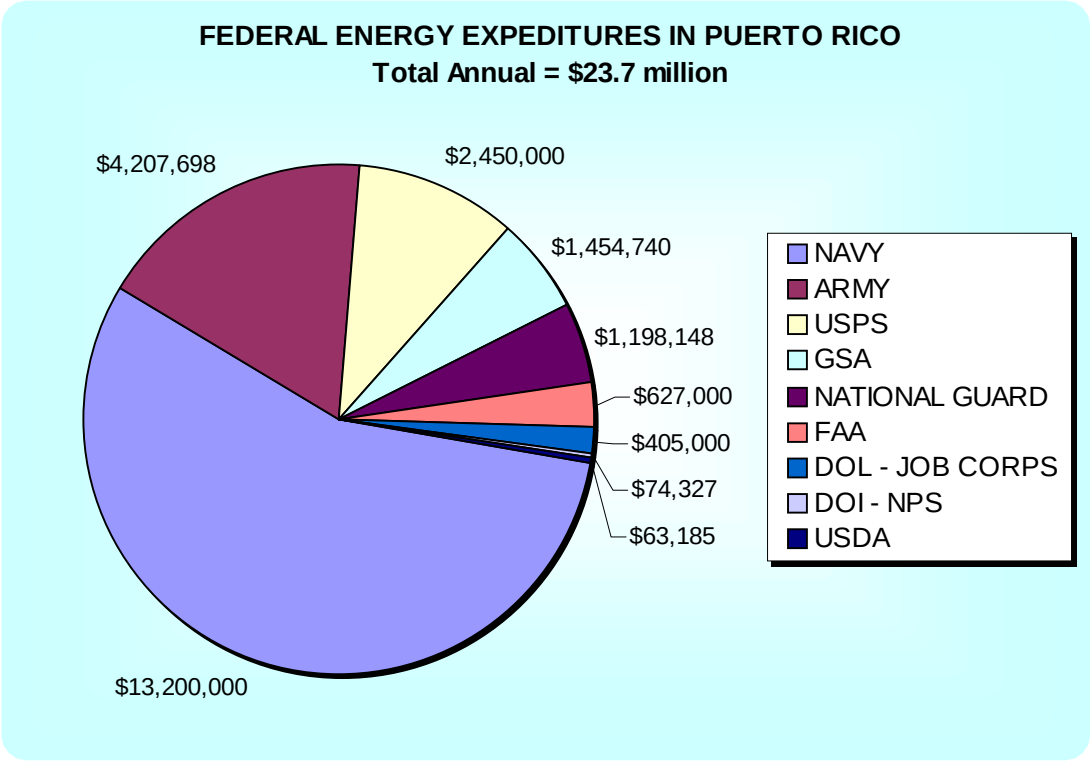
The Ramey Center was originally built in 1958 and turned over to the Department of Labor in 1986. The center has two sites: One site has the office, dormitory, dining hall and new education buildings; the second site has the recreation-education buildings and gymnasium. Building area totals 118,272 square feet. Annual electric cost is about $191,000 per year, and annual water charges are about $70,000 per year. Two diesel-fired water heaters (each in men's and women's dormitory) and one diesel-fired boiler (steam / hot water) in the dinning hall building consume $16,000 per year in diesel fuel.

DEPARTMENT OF INTERIOR - NATIONAL PARK SERVICE

The National Guard Headquarters building in San Juan.

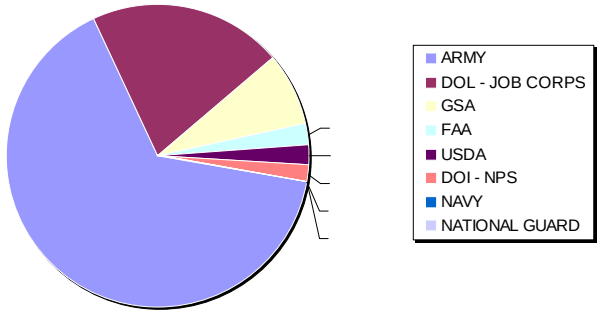
The Gunpowder Magazine at the San Juan National Historic Site

The San Juan National Historic Site is operated by the U.S. Department of the Interior's (DOI) National Park Service (NPS) in Old San Juan, Puerto Rico. The Site is comprised of the Spanish-built forts of El Morro, San Cristobal, El Canuelo, and the city walls. The primary resource intensive areas are El Morro and San Cristobal, with eight buildings and total floor area of 278,553 square feet. The main buildings are massive masonry fortifications first built almost 500 years ago at the northeastern edge of Old San Juan. These buildings are used for various purposes including office, museum, visitors use, housing, storage, and a work area. Annual electric cost is about $74,400 per year with an ECI of $0.27 per square foot per year. Annual water charges are about $10,500 per year.



DEPARTMENT OF AGRICULTURE

The main building at the U.S. Department of Agriculture (USDA) Tropical Research Station in Mayaguez is a single-story plus basement, 13,576 square foot building constructed in 1909. It is comprised of laboratories, offices, and supporting facilities. The building is conditioned by split-system and window type unitary equipment. There are total of 24 air conditioners installed having a capacity ranging between 8,700 and 48,000 Btuh each. All fluorescent lamps in the building are 4-foot T-12 40-Watt with magnetic ballast. There is also a 150 kW diesel generator at the site. Annual electric cost is about $63,200 per year with an ECI of $4.65 per square foot per year. Annual water charges are about $13,000 per year.



5.2 Potential energy, water, and dollar savings

Federal facility energy use in Puerto Rico is about $21.2 million per year, and the overall energy cost index (ECI) is high at $2.18 per square foot per year. Water consumption expenditures for Federal facilities in Puerto Rico are estimated to be about $2 million per year. Because of their size, potential total dollar savings is greatest at Ft. Buchanan (U.S. Army) and Roosevelt Roads (U.S. Navy). The GSA buildings, the National Guard, the FAA facilities, and the Job Corps centers also have large potential dollar savings. Our findings indicate that potential annual savings are on the order of $5 to $8 million per year. This would support a project implementation budget of around $30 million.

Most opportunities for retrofit of high efficiency motors are at the larger buildings.

5.3 Energy and water audits

The Roosevelt Roads NSTA Energy Manager requested assistance with detailed energy audits, which would include application of renewable energy technologies. He indicated that there might be some Naval Station co-funding available, but that a Super ESPC is the most likely avenue for project implementation.

According to the local point-of-contact for GSA, there are no qualified local GSA personnel to work in the energy efficiency area. The agency has hired consulting firms to perform limited energy audits and has elected to participate in the SAVEnergy audit program. Lighting opportunities for improved energy efficiency were identified in these audits; however, renewable and HVAC energy conservation measures (ECMs) were not identified. The lack of local agency expertise coupled with the availability of agency capital provides a unique opportunity to implement renewable, HVAC, and lighting ECMs in a whole-building approach. Additional resources are needed to assist this agency in making the most of this opportunity.

The FAA CERAP Administration Building.

The representative from the FAA was not aware of efforts for energy conservation other than participation in the SAVEnergy program. The primary focus of energy conservation is handled through the FAA's Miami, Florida office. They could use assistance in the review of designs for renovation and/or new construction.

5.4 Technology retrofits

Roosevelt Roads has completed a lighting retrofit of most existing buildings. The program was divided into two projects: one performed by an ESPC and one performed by a contractor paid by the Navy. From our site inspection of the retrofits, it was observed that light levels were approximately 80% higher than required. Fixtures were not tandem wired and used two ballasts per four-lamp fixture without the benefit of energy-saving inboard / outboard controls. The result was to create a situation where lighting power consumption is almost twice greater than required, and much of the opportunity to capture additional savings has been depleted.

The Ramey Job Corps Center New Education Building

Roosevelt Roads is currently installing high-efficiency water-cooled chiller plants at three locations. One plant has just been completed and is operational. The contractors have done an excellent job in both the design and operation of this new plant. However, there are still a few energy saving opportunities to improve plant efficiency further, such as control optimization sequencing and adjustable chiller drives. The energy manager is also considering a motor replacement program whereby older, high horsepower motors will be systematically replaced with premium-efficiency motors.

Ft. Buchanan uses multiple air-cooled chillers for space cooling, which are in poor condition and extremely inefficient. The aluminum fins on the condensing unit have not been protected against salt air corrosion and have therefore deteriorated to the point of non-functionality despite their age of less than 4 years. Coatings are available, including ADSIL and Bronze-Glo which will maintain the structural integrity and heat transfer capability of the coils (provided that they are properly maintained), but were not seen in use at this facility. Multiple split-systems and package air conditioning units were observed in similar condition.

The unmanned FAA Borinquen VOR.

Lighting at Ft. Buchanan is primarily T12 34-Watt lamps with magnetic ballasts. Light levels were at or above required levels. Straight T8 retrofits would result in overlit spaces. Manual controls were used but many examples of offices and work areas were observed to be vacant with lights remaining on. Photocell controls of exterior lighting had failed in many instances resulting in exterior lighting being on during daylight hours.

The National Guard has installed T8 lights and electronic ballasts in their headquarters facility in Old San Juan, resulting in excessive lighting levels for office space. They are currently implementing a pilot project involving waterless urinals using repair and alteration money. They have a meeting set up with Tropigas to discuss possible DSM opportunities. The projects observed to-date did not address HVAC opportunities and did not reduce lighting consumption as much as can be accomplished with an engineered whole-building approach.

5.5 Advanced and renewable technology implementation

Puerto Rico government has long recognized that PREPA meets 98 percent of its energy needs from imported oil. Numerous studies have identified and repeatedly confirmed solar and wind technology as viable for many applications. Distributed generation could provide peak shaving, substation capacity deferral, and improved power quality and reliability. Waste-to-energy power plants may also be economically viable renewable energy sources for Puerto Rico. Solid waste is now burned, landfilled, or hauled off the island at great expense. Despite the potential, these indigenous resources remain largely under-developed.

It is anticipated that significant infrastructure improvements, renewable technologies, and demand side management strategies will be targeted for implementation as part of a larger energy project. There exists significant opportunity for application of solar air conditioning, grid-connected photovoltaic and wind electric generation systems, solar water heating, ground-source heat pumps, day lighting, combined heat and power, and waste heat-to-energy technology. Possible projects identified at Federal sites include installation of solar-PV panels, installation of a wind turbine, and installation of small solar water heating systems.

Under the Public Utilities Regulatory Polices Act (PURPA), utilities are required to purchase electricity from small power producers such as solar and wind generators. On Puerto Rico, generators will most likely need to be smaller than 100kW so that grid interconnection and net-metering requirements can be simple. Installations smaller than 25 kW usually require very little evaluation of the local distribution system. Benefits to PREPA may include delayed investment in grid upgrades, reduction in transmission losses and increased load serving capability. Costs for constructing a wind electric unit have ranged from $1,000 to $3,000 per

Constant steady trade winds from the east over Puerto Rico are a valuable energy resource.

installed kW at existing sites in the U.S. and Europe. The cost of electricity generated from the turbines ranges from $0.07 to $0.15 per kWh – competitive with utility power currently priced at from $0.09 to $0.14 per kWh in Puerto Rico. At a total installed cost of around $6,500 per kW and a 20-year system life, solar-PV electricity could be produced competitively at $0.14 to $0.18 per kWh.

The abundance of solar energy in Puerto Rico is among the world's highest, averaging about 2010 kWh per square meter annually[4]. Together with the high cost of electricity and warm climate, this makes the island well suited for cost-effective installations of solar water heating panels and PV systems. Nationwide, the NPS has installed over 500 PV systems and may be the first agency to work with FEMP on pilot solar and wind sites in Puerto Rico.

Wind direction along coastal Puerto Rico is predominately from the east; its deviation north and south of east can be determined quite accurately by an analysis of the wind flow over the eastern Caribbean. It is the wind speed, rather than direction, that is the more variable factor and needs further investigation.

Ground-source heat pumps use the relatively constant temperature of soil, estimated to be about 77 to 80 degrees F in Puerto Rico, as a heat sink for a heat pump, which provides cooling for buildings. A variation that uses surface water as a heat sink may be viable for facilities located close to the sea or a harbor. The equipment does not have a coil exposed to the corrosive salt air like conventional air conditioners. Instead it uses a buried coil of tubing to reject heat to the ground, or submerged at the bottom where the water is cooler. The higher initial cost is more than offset by the lower costs for maintenance and energy.

Many facilities are equipped with a diesel or LNG back-up electric generation set.

Replacement of wall-hung 3.0 gpf or 1.0 gpf units with waterless models is a significant water saving opportunity at all Federal sites visited.

[4] At a solar collector tilt angle equal to the latitude. For comparison, Atlanta GA averages about 1,860 and Honolulu averages 2,080 kWh/m2; Anchorage, AK 1,100; New York 1,680; and Solar One, CA averages 2,400 kWh/m^2. Source: Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors; 30-Year Average of Monthly Solar Radiation, 1961-1990; U.S. DOE/NREL.

5.6 Water Resources

Use of solar distillation, rainwater catchment, and graywater recycling systems is yet another opportunity for major water and energy savings. The scarcity and expense of potable water makes efforts at conservation, recycling, and rain water catchment especially worthwhile. Retrofitting restrooms with waterless urinals, 1.6 gpf water closets and 1.5 gpm faucet aerators would reduce water use by 3.8 gallons per day for each person working in the building, a reduction of approximately 60 percent.

5.7 Planning, management, training, and O&M

The Puerto Rico Energy Affairs Administration staff is interested in implementing energy saving and renewable energy projects in all sectors and at all levels. The local government has minimal resources to invest in energy efficiency projects and most of the Federal facilities are too small to attract an ESCO. A creative approach will be required in order to implement projects at the small, non-DOD Federal facilities. One strategy for pursuing projects here might be through a cross-agency aggregated energy efficiency performance contract.

The need for training is comprehensive in Puerto Rico. Maintenance practices are sub-standard compared with the mainland U.S. Examples of deficiencies include T12 lamps installed with electronic ballasts, T8 lamps installed with magnetic ballasts, dirty filters and evaporator coils on HVAC equipment, corroded condenser fins, inoperative controls, and inadequately maintained mechanical equipment.

The Ft Buchanan energy manager requested help with energy program planning, training, facility auditing, project funding, and assistance in developing a comprehensive energy management plan. The Army base is currently under a moratorium on capital projects, and may be turning the facility over to the National Guard, so it is not clear how to proceed. Regardless of which agency occupies the facility, energy savings will benefit Federal budget items. The best bet is to apply DOE/FEMP funds to conduct an intensive base energy audit and prepare an energy management action plan that will be applicable and transferable if/when the Army moves out and the National Guard moves in.

According to the Roosevelt Roads NSTA Energy Manager, they are in need of training and comprehensive energy audits. Naval projects are managed from New York and Norfolk Virginia, so an intentional effort will be required to pursue further opportunities here.

The National Guard Energy Manager requested assistance with the development of a comprehensive Energy Management Action Plan (EMAP) to prioritize the opportunities in their jurisdiction and to map out a strategy for achieving/exceeding requirements to reduce energy consumption 35% by 2010.

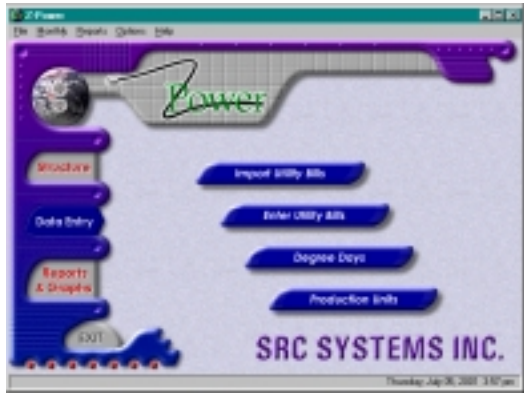
Roosevelt Roads holds regular energy manager workshops on site. However, FEMP training is made available only to the highest level Utilities Branch Manager. They have requested additional training from the DOE, preferably on-site for the benefit of mechanics and building maintenance staff. They have also developed a draft Energy Conservation Program Guideline.

Training seminars and the opportunity to receive on-the-job training from seasoned energy efficiency engineers is desirable to the Puerto Rico Energy Affairs Administration, as well as receiving additional funding to conduct energy-related work.

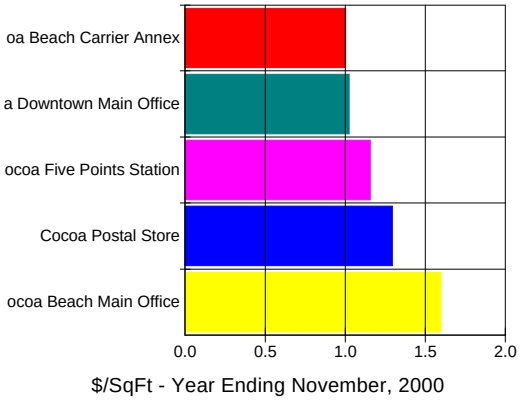
5.8 Energy and water consumption accounting

Tracking and analysis of energy and water use at the facility level will be critical for identifying savings opportunities, aggregating facilities, and to verify that savings are being realized once projects are implemented. Collection and review of utility bills, comparisons between months and with other like facilities, before/after comparisons, EUI/ECI index analysis, and dissemination of the results all serve to increase awareness as well as to validate the efficiency program. Moreover, these activities alone have resulted in as much as 5% savings at other federal sites.

A designated Resource Efficiency Manager, dedicated full time to tracking use & savings, implementation of projects, and identification of additional savings opportunities for all of the smaller, non-DOD Puerto Rico Federal facilities would more than pay for him/her self. Tracking usage, demand, and costs would best be facilitated by PREPA and TropiGas providing



All Energy Services Cost
USPS Central Florida District (Selected Sites)



Software to track and analyze energy use and utility expenditures is a very useful tool for any energy management project. Z-Power is one of the more inexpensive software options.

utility bills in electronic format, or on a web site that could be imported into inexpensive utility analysis software such as Z-Power. However, even manual entry of utility bills would prove worthwhile …"*You can't manage what you don't measure.*" All electricity into Ft. Buchanan is through a single meter; some tenants currently are sub-metered, but the majority of the structures and facilities, including housing, are not sub-metered resulting in wasteful and untracked consumption in these areas.

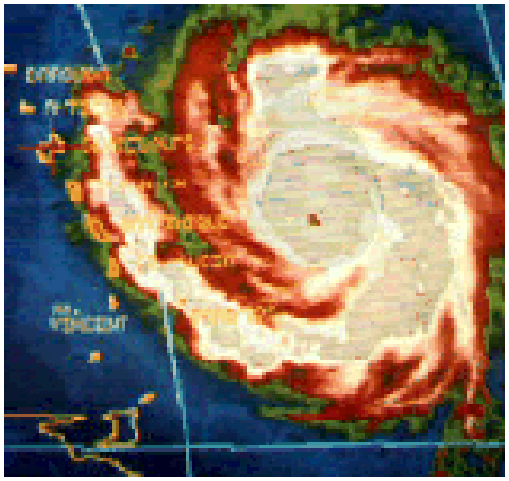
6. Barriers to Implementation

Common barriers to the implementation of energy efficiency and renewable energy projects in the U.S. Caribbean are: (1) the small facility sizes are insufficient to attract the interest of most ESCOs, and (2) the lack of awareness of the savings and other benefits available through energy improvement projects.

The primary barrier at the smaller sites, with the exception of the DOD and GSA buildings, is lack of funding to implement the projects. A performance contract approach will be required to implement projects at smaller non-DOD and non-GSA sites. During our data collection we were unsuccessful in identifying local firms specializing in energy engineering; however, there are local contractors who could implement energy projects given guidance from qualified energy engineers and design documents.

The major barrier for ESCO-assisted implementation is the size of the non-DOD Federal facilities. Most ESCOs are somewhat uninterested in implementing projects at sites having annual utility expenditures less than $0.5 to $1 million. Although these projects, if aggregated, would exceed this threshold, no agency has facilities at a single location that approach this threshold. Some agencies do not exceed the threshold even when all of their facilities are aggregated. Multiple Federal agencies cannot be bundled[5] into a project for a competitive ESCO award; therefore, an alternative ESCO approach will be required to ensure that all agencies are included in the program

Another barrier is the threat of tropical storms and hurricanes, which poses a significant risk to investments within the Island infrastructure, especially to wind power.



Hurricanes that have passed near or hit Puerto Rico include Hose and Lenny (1999), Georges (1998), Bertha and Hortense (1996), Luis, Marilyn and Sebastian (1995), Hugo (1989), ...

[5] source: meeting with DOE-FEMP staff at the ARO.

Roosevelt Roads Naval Base

The Navy has been proactive in their approach to pursuing demand side management projects. Lighting and air conditioning upgrades have been performed or are underway. Renewable projects have not been included due to the lack of incentive for the ESCO to pursue this type of project. A comprehensive energy management action plan (EMAP) is needed to prioritize and identify facilities that could benefit from advanced and renewable technologies.

Fort Buchanan

The primary barrier to project implementation here has been the uncertainty of the tenant status of the Army. The political climate has recently shifted and it appears now that the Army will maintain its presence on the base. The facility is large enough to attract the attention of an ESCO so the remaining barrier will be to promote renewable technologies to the selected ESCO in hopes of ensuring inclusion of renewable technologies in the resulting project.

General Service Administration

Two primary barriers are associated with this agency. GSA leases much of its building space and administers site improvements via internal funding. A comprehensive energy management action plan (EMAP) is needed to prioritize and identify facilities that could be upgraded with GSA capital. The development of an EMAP would also help overcome the second barrier, which is lack of awareness of the opportunity presented by energy improvement projects. An EMAP would provide a road map for project implementation and identify the source of funding for improvements at each site.

Others:

The FAA, Job Corps, USPS, USDA, and the National Guard alone lack the internal support (manpower and capital) and facility size to attract an ESCO at this time. The USPS is the largest of these five government agencies, but they have not entered the DOE's Super ESPC program. These agencies need to be bundled together in order to attract the services of an ESCO.

7. Project Implementation Strategies

Combining the smaller non-DOD and non-GSA Federal sites into one aggregated performance contract should be considered. Just two federal sites have the need and resources to move forward with a Super-ESPC on their own. They are Roosevelt Roads Naval Station and the Army's Ft. Buchanan. Combining the remaining federal agencies into a cross-agency bundled-ESPC may result in additional alternatively financed projects. The large number of buildings that the Navy and Army operate should position them well for attracting an ESPC to implement additional energy efficiency projects. The availability of capital provides GSA with the rare opportunity to implement projects directly and with lower total costs than using the services of an ESCO.

If an ESCO is selected to finance and implement such a project, local contractors should be used to the greatest extent possible in order to build local energy project implementation capabilities. This will help PREAA encourage technology transfer from the Federal sector to the local private sector and continue implementation of energy projects beyond the present government effort. Following FEMP's lead, it is hoped that enough commercial and industrial operators decide to improve the energy efficiency of their facilities to have a significant beneficial effect on the local economy.

7.1 Approaches to Project Implementation

An Energy Management Action Plan (EMAP) is needed for each agency. The EMAP would prioritize all facilities and provide a multi-year timeline for project implementation. Each agency should receive assistance in developing a plan that will ensure that potential savings are maximized and lower-cost projects be used to assist with the implementation of advanced and renewable technologies. Results of the SAVEnergy audits can provide additional input into the plan development. Capital money should be used for project implementations wherever available.

A pilot/demonstration investment grade audit may also help encourage implementation of projects. The results of such an audit could be used for awareness training of facility energy managers on the advantages of renewable and advanced energy-efficient technologies. It is believed that significant life-cycle cost savings can be achieved and substantial energy efficiency improvements made, provided that the opportunities are presented to the key decision makers.

To attract an ESCO to finance projects for the smaller federal sites, it is recommended that the smaller facilities be bundled together as one project under a FEMP agreement. It is further recommended that a hybrid performance contracting approach be used to meet the needs of smaller federal sites. Under this approach, comprehensive audits and design concept documents would be prepared which include application of renewable energy resources as appropriate. An ESCO would then be tasked to finance and install the identified projects. It is believed that this approach will maximize the benefits to the agencies responsible for paying federal energy bills. This approach will also mitigate some of the project risks and increase the likelihood of securing the services of an ESCO.

Another possible approach is to recruit PREPA as a partner to provide non-competitive demand side management services to cross-agency aggregated facilities. Under this approach, comprehensive audits and design concept documents would be prepared by an ESCO which include extensive application of renewable energy resources. The ESCO would then be tasked to finance and install the identified projects as designed under the PREPA contract umbrella. This approach will also mitigate some of the project risks and increase the likelihood of securing the services of an ESCO, and could be used in combination with the above described partnerships.

To help assure the success of any approach taken, an intensive (one or two full days) seminar should be provided for maintenance personnel, facility managers, engineers, and technicians on Puerto Rico. The course should cover proper maintenance of advanced energy-efficient technologies and the impact on energy consumption. Specific topics should address the opportunities and deficiencies noted in the previous sections, including but not limited to the

effects of mis-matching lamps and ballasts, basic HVAC maintenance, geothermal HVAC maintenance and opportunities, and the benefits and maintenance of renewable technologies.

7.2 Action Plan

The elements of partnering with the serving utility and the local energy office, conducting energy and water audits, and providing training and/or strategic planning assistance will be critical to successful implementation of energy projects at Federal facilities in Puerto Rico.

1. Partner with PREPA

It is suggested that DOE-FEMP present a plan to PREPA that will ensure they become a partner in ESPCs that are implemented.

2. Conduct energy and water audits at smaller facilties

Solutions-Based Audits (not systems based like the SAVEnergy Audits) should be performed at the smaller federal sites. Well-defined projects and savings will greatly increase the number of ESCOs interested in the smaller federal sites because the magnitude of the opportunities will be clarified and risk will be lessened.

3. Develop agency Energy Management Action Plans

An Energy Management Action Plan (EMAP) that prioritizes all facilities and provides a multi-year timeline for project implementation is needed for each agency. Each agency should receive

In a Hybrid-ESPC the ESCO finances the two most costly of the five main components of an energy project.

assistance in developing a plan that will ensure that potential savings are maximized and lower-cost projects be used to assist with the implementation of advanced and renewable technologies.

4. Perform detailed wind energy studies and establish standards

Wind studies are needed to investigate local wind power availability at specific candidate sites; grid and substation capacities, hurricane protection, siting, permitting and zoning issues, and sources for purchase/shipment of turbines and towers. It would be beneficial for such a study to address costs, including the cost of resource assessments, capital costs (turbine, tower, foundation, grid connection), the interconnection approval process, O&M, and land costs, and include a small scale pilot demonstration.

A utility engineer should be tasked to evaluate each proposed installation. Establishment of Predefined Interconnection Standards to streamline evaluation of proposed installations for various distribution regions is needed. A primary consideration for siting grid connected wind turbines, as well as non-storage photovoltaic panels, is the robustness of the electric distribution system at the point of interconnection. Three-phase lines are required within one mile of the site for connecting turbines larger than about 20 kW. Turbine capacity can be no greater than 5% to 10% of the line rating[6]. Power quality considerations may constrain siting to within 10 miles or less of a substation. Capacity may be limited to the kW that would cause no more than a 2% voltage variation on the line.

5. Offer a training / workshop event

An intensive two-day seminar for maintenance personnel, facility managers, engineers, and technicians on Puerto Rico is needed. The event should cover proper maintenance of advanced energy-efficient technologies and the impact on energy consumption. Specific topics should

[6] expressed as short-circuit MVA – MegaVolt-Amperes

address the effects of mis-matching lamps and ballasts, basic HVAC equipment, and solar and wind generation.

6. Implement projects and verify savings

The selected ESCO(s) will provide a proposal for implementation of projects. Local subcontractors will be employed to the maximum extent possible with the ESCO providing any additional personnel needed. At this time investment grade audits will be performed which include application of viable renewable projects. It is estimated that the program could be implemented over approximately four years once the contracts have been established.

7. Take measures to maintain savings

To the maximum extent practicable, local personnel should be trained in operation and maintenance of installed systems. It should be noted that many facilities will be capable of maintaining their own facility improvements. Where staff are available for this function, training should be provided to these staff. This will minimize the payments to the ESCO for post-construction services and provide for a more attractive payback. At facilities where staff are not available, the ESCO may be tasked with providing O&M services. Although this will increase the cost of the project and consequently the associated payback period, the additional investment will ensure that the equipment will continue to function as designed and that comfort conditions as well as savings will continue to be realized.

8. Local Resources: Engineering, Products, and Financing

8.1.1 LISTING BY COMPANY , SPECIALIZATION AND RATING AT A GLANCE

Company Name	Specialty	Star Rating
CSA Architects & Engineers	Energy	4
SOLARTEK	Energy	4
MEC Engineering, P.S.C.	Energy	2
Beato & Associates	Energy	2
SOLECTRICA CORPORATION	Energy	2
SUNERGY	Energy	2
Tetra Tech Caribe	Water	3
Fernando Rodriguez P.E. & Associates	Water	3
Environmental Resource Technologies	Water	2
On-Site Environmental, Inc.	Water	2
Gaya & Asociados Ingenieros C.S.P.	Environmental	2
TERRA VAC	Environmental	2
Applied Geoscieences & Environmental Services	Environmental	2
Environmental Resources Technologies	Environmental	2
JB & Associates	Environmental	1
SPECCO Environmental ,Inc.	Environmental	1

ENVIROSAFE	Environmental	1
Company Name	**Specialty**	**Star Rating**
CMA Architects & Engineers	Design/Build	3
Raymond Professional Group, Puerto Rico Engineering Group	Design/Build	3
3/0 Construction S.E.	Design/Build	2
Caribbean Resort Construction	Design/Build	1
Dick Corporation	Design/Build	1
PLUSHMECH CONTRACTORS	AHU	3
ALARM & CONTROL SYSTEM	AHU	2
ENSY CORPORATION	AHU	2
ACR System, Inc.	AHU	2
Air Technical Systems & Balancing, Inc.	AHU	2
Intercity Mechanical Services of Puerto Rico	AHU	1
Preventative Maintenance Services Corporation	AHU	1
E.V. Mechanical Contractors	AHU	1
General Electric del Caribe	Controls/Electrical Supplies	3
Manuel Freije Arce Inc.	Controls/Electrical Supplies	3
Marina Electric Inc.	Controls/Electrical Supplies	2
Monge & Davila Electrical Co.	Controls/Electrical Supplies	2

Roger Electric Co. Inc.	Controls/Electrical Supplies	2
Company	**Specialty**	**Star Rating**
PAS Technologies, Inc.	Controls	2
AG group inc.	Controls	2
AlLARM CONTROL SYSTEM	Controls/Electrical Supplies	2
OSRAM SYLVANIA	Electrical Supplies	2
PRIME CONTROLS	Controls	2
Antilles Auxiliary Power, inc.	Electrical Supplies	2
Graybar International	Controls/Electrical Supplies	2
Wartsilan NSD Caribbean, Inc.	Controls	1
Caparra Controls & Engineering	Controls	1
Intelli Controls	Controls	1
Isidro Ramos, Inc.	Controls/Electrical Supplies	1
ATAN Inc.	A/C	1
CHEMPROD Corporation	Chemicals	1
Max Chemical Inc./ CROSSCO	Chemicals	1
PALL Puerto Rico	Filters	1
DR & J Manufacturers Representative	Construction Materials	1
Carrier Puerto Rico	A/C	1
ANERON, Inc.	A/C	1
YORK International	A/C	1
TECHNO-LITE de P.R.	Plumbing Supplies	3
Plom Electric Imagination Corporation	Plumbing Supplies	2
SYSTRONICS Inc.	Office Equipment	2

Copier Depot Corp.	Office Equipment	2
Company	**Specialty**	**Star Rating**
IGM Corporation	Office Equipment	1
LANIER Puerto Rico Inc.	Office Equipment	1
SHRED-IT	Paper recycling	1
Resources Recycling Inc. DBA ATSI-PR	Tire Recycling	1
Puerto Rico Used Oil Collector	Oil Recycling	1
Registe Enterprises	Energy	2
Steve Hutchins Architects & Engineers	Energy	2
West Indies Solair	Energy	2
Environmental Resources Technologies	Water	2
R.R. Caribbean, inc.	Water	2
Benton Construction Company Inc.	Design/Build	2
Taller Larjas Architects	Design/Build	2
Innovations By Design	Design/Build	1
DE Haas Associates Architects & Planners	Design/Build	1
Yssis Group P.C.	Design/Build	1
AIRS”R”US	AHU Contractors	2
Confidence Maintenance & Repair	AHU Contractors	2

Caribbean Cooling	AHU Contractors	2
Company	**Specialty**	**Star Rating**
Bengoas Air Conditioning	AHU Contractors	2
David Wood refrigeration & A/C	AHU Contractors	1
Triumpho Electrical Contractors	Electrical Contractors	1
Sonny's Air Conditioning & Refrigeration Services	AHU Contractors	1
Quality Electrical Supply	Electrical Supplies	2
Electric World	Electrical Supplies	2
The Sea Chest	Building Supplies	1
Red Hook Ace	Building Supplies	1
Crown Mountain Water	Plumbing Supplies	1
Spencely Office Equipment	Office Equipment	1